CLAIMS

What is claimed is:

1. A plastic comprising a polymer admixed with a mineralized ash filler.

2. The plastic of claim 1, wherein the polymer is a thermoplastic.

3. The plastic of claim 2, wherein the polymer is substantially a homopolymer selected from the group consisting of polyolefins, polyoxymethylenes, polystyrenes, polyamides, polyimides, polyesters, fluoropolymers, polyacrylates, polyarylates, polyaryletherketones, polynitriles, polybenzimidazoles, polycarbonates, polyethers, polyphenylene ethers, polyphenylene sulfides, polysulfones, polyaryl sulfones, polyvinyl chlorides, and polyurethanes.

4. The plastic of claim 2, wherein the polymer is a copolymer of at least two polymers selected from the group consisting of polyolefins, polyoxymethylenes, polystyrenes, polyamides, polyimides, polyesters, fluoropolymers, polyacrylates, polyarylates, polyaryletherketones, polynitriles, polybenzimidazoles, polycarbonates, polyethers, polyphenylene ethers, polyphenylene sulfides, polysulfones, polyaryl sulfones, polyvinyl chlorides, and polyurethanes.

5. The plastic of claim 2, wherein the polymer is a polymer of at least one monomer selected from the group consisting of ethylene, propylene, 1-pentene, 1-butene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-decane, styrene, acrylonitrile, maleic anhydride, butadiene, ethylidene norbornene, 1,4-hexadiene, 1,5-hexadiene, 1,7-octadiene, 1,9-decadiene, vinyl chloride, and dicyclopentadiene.

6. The plastic of claim 2, wherein the polymer is a blend of at least two polymers selected from the group consisting of polyolefins, polyoxymethylenes, polystyrenes, polyamides, polyimides, polyesters, fluoropolymers, polyacrylates, polyarylates, polyaryletherketones, polynitriles, polybenzimidazoles, polycarbonates, polyethers, polyphenylene ethers, polyphenylene sulfides, polysulfones, polyaryl sulfones, polyvinyl chlorides, and polyurethanes.

7. The plastic of claim 6, wherein the polymers are miscible.

8. The plastic of claim 6, wherein the polymers are immiscibly blended.

9. The plastic of claim 1, wherein the polymer is a thermoset.

10. The plastic of claim 9, wherein the polymer is selected from the group consisting of diallyl phthalates, amine-formaldehyde polymers, cyanate esters, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, acrylamates, and vinyl esters.

11. The plastic of claim 1, comprising not more than about 60% by weight mineralized ash filler.

12. The plastic of claim 1, comprising not more than about 40% by weight mineralized ash filler.

13. The plastic of claim 1, comprising not more than about 25% by weight mineralized ash filler.

14. The plastic of claim 1, comprising from 5% to 40% by weight mineralized ash filler.

15. The plastic of claim 1, comprising from 5% to 25% by weight mineralized ash filler.

16. The plastic of claim 1, wherein the composition comprises the mineralized ash filler in an amount sufficient to lower the viscosity of the composition at a temperature in the range 170 to 270 degrees Celsius, relative to the viscosity of the polymer alone at the same temperature and shear rate.

17. The plastic of claim 1, wherein the mineralized ash filler comprises a mineralized fly ash.

18. The plastic of claim 17, wherein the mineralized fly ash is obtained from a coal-burning furnace.

19. The plastic of claim 17, wherein the leachable metal content of the mineralized fly ash is not greater than about 10 milligrams per milliliter, as assessed using ASTM Standard Test Method D3682-01.

20. The plastic of claim 17, wherein the leachable metal content of the mineralized fly ash is not greater than about 5 milligrams per milliliter, as assessed using ASTM Standard Test Method D3682-01.

21. The plastic of claim 17, wherein the leachable metal content of the mineralized fly ash is not greater than about 2 milligrams per milliliter, as assessed using ASTM Standard Test Method D3682-01.

22. The plastic of claim 17, wherein the leachable metal content of the mineralized fly ash is not greater than about 1 milligram per milliliter, as assessed using ASTM Standard Test Method D3682-01.

23. The plastic of claim 17, wherein i) the leachable lead content of the mineralized fly ash is not greater than about 0.2 milligram per milliliter; ii) the leachable chromium content of the mineralized fly ash is not greater than about 0.5 milligram per milliliter; and iii) the leachable cadmium content of the mineralized fly ash is not greater than about 0.1 milligram per milliliter, as assessed using ASTM Standard Test Method D3682-01.

24. The plastic of claim 17, wherein not more than about 1% by weight of the ash particles are retained on an American Standard Sieve Series (ASSS) No. 30 sieve.

25. The plastic of claim 17, wherein not more than about 1% by weight of the ash particles are retained on an ASSS No. 50 sieve.

26. The plastic of claim 17, wherein not more than about 5% by weight of the ash particles are retained on an ASSS No. 100 sieve.

27. The plastic of claim 17, wherein not more than about 25% by weight of the ash particles are retained on an ASSS No. 200 sieve.

28. The plastic of claim 1, wherein the mineralized ash filler comprises at least 5% by weight cenospheres.

29. The plastic of claim 1, wherein the number average aspect ratio of the mineralized ash filler is not greater than about 10.

30. The plastic of claim 29, wherein the number average aspect ratio of the mineralized ash filler is not greater than about 2.

31. The plastic of claim 1, wherein the number average Krumbein particle roundness of the mineralized ash filler is not less than about 0.7.

32. The plastic of claim 1, wherein the number average Krumbein particle sphericity of the mineralized ash filler is not less than about 0.7.

33. The plastic of claim 1, further comprising a second filler.

34. The plastic of claim 33, wherein the second filler is a nanofiller.

35. The plastic of claim 34, wherein the nanofiller is a nanotalc.

36. The plastic of claim 34, wherein the nanofiller is a nanoclay.

37. The plastic of claim 36, wherein the nanoclay has been surface-treated to decrease association of nanoclay particles with one another.

38. The plastic of claim 37, wherein the nanoclay is selected from the group consisting of a smectite-derived nanoclay, a kaolinite-derived nanoclay, a vermiculite-derived nanoclay, a halloysite-derived nanoclay, a mica-derived nanoclay, a phlogopite-derived nanoclay, and a silicate-derived nanoclay.

39. The plastic of claim 37, wherein the nanoclay is a smectite-derived nanoclay.

40. The plastic of claim 39, wherein the nanoclay is selected from the group consisting of montmorillonite, saponite, beidellite, nontrite, sauconite, and hectorite.

41. The plastic of claim 40, wherein the nanoclay is montmorillonite.

42. The plastic of claim 36, comprising not more than about 7% by dry weight of the nanoclay.

43. The plastic of claim 36, wherein the number average maximum dimension of the nanoclay particles is not greater than about 500 nanometers.

44. The plastic of claim 43, wherein the number average maximum dimension of the nanoclay particles is from 5 to about 500 nanometers.

45. The plastic of claim 36, wherein the number average aspect ratio of the nanoclay particles is not less than about 100.

46. The plastic of claim 45, wherein the number average aspect ratio of the nanoclay particles is not less than about 1000.

47. The plastic of claim 1, further comprising an additional ingredient selected from the group consisting of plasticizers, stabilizers, flow modifiers, lubricants, additional fillers, and coloring agents.

48. A manufactured article comprising the plastic of claim 1.

49. The article of claim 48, formed into a building material.

50. The article of claim 49, wherein the building material is selected from the group consisting of roofing, siding, insulation, piping, railing, fencing, decking, flooring, framing, and trimming materials.

51. The article of claim 49, wherein the building material is a plank.

52. The article of claim 49, wherein the building material is an ornamental building material.

53. The article of claim 49, wherein the building material is a structural building material.

54. The article of claim 48, comprising a layer of the composition adhered to a material.

55. The article of claim 54, wherein the layer surrounds the material.

56. The article of claim 54, comprising multiple layers of the composition adhered to the material.

57. The article of claim 54, wherein the material is selected from the group consisting of wood, plywood, pressboard, and particleboard materials.

58. The article of claim 54, wherein the material is a metal comprising at least one of iron, steel, copper, and aluminum.

59. A method of making a plastic, the method comprising incorporating a mineralized ash filler into a polymer resin and thereafter solidifying the resin to form the plastic.

60. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin using an apparatus selected from the group consisting of extruders, roller mills, and static mixers.

61. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an extruder.

62. The method of claim 61, wherein the extruder is selected from the group consisting of a single-screw extruder, a twin-screw extruder, and a ram extruder.

63. The method of claim 61, wherein the extruder is coupled with a die for conferring a shape to plastic extruded from the apparatus.

64. The method of claim 63, wherein a feed block is interposed between the extruder and the die for splitting and redirecting the resin prior to feeding the resin to the die.

65. The method of claim 59, wherein the polymer resin is shaped prior to solidifying the resin.

66. The method of claim 65, wherein the polymer is formed into a shape selected from the group consisting of a plank, a sheet, a tube, and a pellet prior to solidifying the resin.

67. The of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin by combining the resin and the filler and agitating the combination prior to solidifying the resin.

68. The method of claim 64, wherein the combination is molded prior to solidifying the resin.

69. The method of claim 59, further comprising incorporating a nanofiller into the resin prior to solidifying the resin.

70. The method of claim 69, wherein the nanofiller is a nanoclay.

71. The method of claim 70, wherein the nanoclay is incorporated into the resin by co-extruding a resin precursor and a second polymer having the nanoclay suspended therein.

72. The method of claim 59, wherein the polymer is a thermoplastic.

73. The method of claim 72, wherein the polymer is substantially a homopolymer selected from the group consisting of polyolefins, polyoxymethylenes, polystyrenes, polyamides, polyimides, polyesters, fluoropolymers, polyacrylates, polyarylates, polyaryletherketones, polynitriles, polybenzimidazoles, polycarbonates, polyethers, polyphenylene ethers, polyphenylene sulfides, polysulfones, polyaryl sulfones, polyvinyl chlorides, and polyurethanes.

74. The method of claim 72, wherein the polymer is a copolymer of at least two polymers selected from the group consisting of polyolefins, polyoxymethylenes, polystyrenes, polyamides, polyimides, polyesters, fluoropolymers, polyacrylates, polyarylates, polyaryletherketones, polynitriles, polybenzimidazoles, polycarbonates, polyethers, polyphenylene ethers, polyphenylene sulfides, polysulfones, polyaryl sulfones, polyvinyl chlorides, and polyurethanes.

75. The method of claim 72, wherein the polymer is a polymer of at least one monomer selected from the group consisting of ethylene, propylene, 1-pentene, 1-butene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-decane, styrene, acrylonitrile, maleic anhydride, butadiene,

ethylidene norbornene, 1,4-hexadiene, 1,5-hexadiene, 1,7-octadiene, 1,9-decadiene, vinyl chloride, and dicyclopentadiene.

76. The method of claim 72, wherein the polymer is a blend of at least two polymers selected from the group consisting of polyolefins, polyoxymethylenes, polystyrenes, polyamides, polyimides, polyesters, fluoropolymers, polyacrylates, polyarylates, polyaryletherketones, polynitriles, polybenzimidazoles, polycarbonates, polyethers, polyphenylene ethers, polyphenylene sulfides, polysulfones, polyaryl sulfones, polyvinyl chlorides, and polyurethanes.

77. The method of claim 76, wherein the polymers are miscible.

78. The method of claim 59, wherein the polymer is a thermoset.

79. The method of claim 78, wherein the polymer is selected from the group consisting of diallyl phthalates, amine-formaldehyde polymers, cyanate esters, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, acrylamates, and vinyl esters.

80. The method of claim 59, wherein the mineralized ash filler is provided in the form of a second polymer comprising not less than 50% by weight of the mineralized ash filler.

81. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an amount not greater than about 60% by weight of the polymer.

82. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an amount not greater than about 40% by weight of the polymer.

83. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an amount not greater than about 25% by weight of the polymer.

84. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an amount from 5% to 40% by weight of the polymer.

85. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an amount from 5% to 25% by weight of the polymer.

86. The method of claim 59, wherein the mineralized ash filler is incorporated into the polymer resin in an amount sufficient to lower the viscosity of the resin.

87. The method of claim 59, wherein the mineralized ash filler comprises a mineralized fly ash.

88. The method of claim 87, wherein the mineralized fly ash is obtained from a coal-burning furnace.

89. The method of claim 87, wherein the metal content of the mineralized fly ash is not greater than about 10 parts per million.

90. The method of claim 87, wherein the metal content of the mineralized fly ash is not greater than about 5 parts per million.

91. The method of claim 87, wherein the metal content of the mineralized fly ash is not greater than about 2 parts per million.

92. The method of claim 87, wherein the metal content of the mineralized fly ash is not greater than about 1 part per million.

93. The method of claim 87, wherein i) the lead content of the mineralized fly ash is not greater than about 1 part per million; ii) the chromium content of the mineralized fly ash is not greater than about 1 part per million; and iii) the cadmium content of the mineralized fly ash is not greater than about 1 part per million.

94. The method of claim 87, wherein not more than about 1% by weight of the ash particles are retained on an American Standard Sieve Series (ASSS) No. 30 sieve.

95. The method of claim 87, wherein not more than about 1% by weight of the ash particles are retained on an ASSS No. 50 sieve.

96. The method of claim 87, wherein not more than about 5% by weight of the ash particles are retained on an ASSS No. 100 sieve.

97. The method of claim 87, wherein not more than about 25% by weight of the ash particles are retained on an ASSS No. 200 sieve.

98. The method of claim 59, wherein the mineralized ash filler comprises at least 5% by weight cenospheres.

99. The method of claim 59, wherein the number average aspect ratio of the mineralized ash filler is not greater than about 10.

100. The method of claim 99, wherein the number average aspect ratio of the mineralized ash filler is not greater than about 2.

101. The method of claim 59, wherein the number average Krumbein particle roundness of the mineralized ash filler is not less than about 0.7.

102. The method of claim 59, wherein the number average Krumbein particle sphericity of the mineralized ash filler is not less than about 0.7.

103. The method of claim 59, further comprising incorporating into the polymer resin a second filler prior to solidifying the resin.

104. The method of claim 103, wherein the second filler is a nanofiller.

105. The method of claim 104, wherein the nanofiller is a nanotalc.

106. The method of claim 104, wherein the nanofiller is a nanoclay.

107. The method of claim 106, wherein the nanoclay has been surface-treated to decrease association of nanoclay particles to one another.

108. The method of claim 107, wherein the nanoclay is selected from the group consisting of a smectite-derived nanoclay, a kaolinite-derived nanoclay, a vermiculite-derived nanoclay, a halloysite-derived nanoclay, a mica-derived nanoclay, a phlogopite-derived nanoclay, a silicate-derived nanoclay.

109. The method of claim 107, wherein the nanoclay is a smectite-derived nanoclay.

110. The method of claim 109, wherein the nanoclay is selected from the group consisting of montmorillonite, saponite, beidellite, nontrite, sauconite, and hectorite.

111. The method of claim 110, wherein the nanoclay is montmorillonite.

112. The method of claim 106, comprising not more than about 7% by dry weight of the nanoclay.

113. The method of claim 106, wherein the number average maximum dimension of the nanoclay particles is not greater than about 500 nanometers.

114. The method of claim 113, wherein the number average maximum dimension of the nanoclay particles is from 5 to about 500 nanometers.

115. The method of claim 106, wherein the number average aspect ratio of the nanoclay particles is not less than about 100.

116. The method of claim 115, wherein the number average aspect ratio of the nanoclay particles is not less than about 1000.

117. The method of claim 59, further comprising incorporating into the polymer resin an additional ingredient selected from the group consisting of plasticizers, stabilizers, flow modifiers, lubricants, additional fillers, and coloring agents, prior to solidifying the resin.

118. A method of making a plastic article, the method comprising incorporating a mineralized ash filler into a polymer resin and thereafter shaping and solidifying the resin to form the plastic article.

119. The method of claim 118, further comprising machining the shaped and solidified resin.

120. The method of claim 118, further comprising assembling the article from the shaped and solidified resin and at least one other item.

121. A composition of matter comprising a matrix material admixed with a mineralized ash filler.

122. The composition of claim 121, wherein the matrix material is selected from the group consisting of a hydraulically settable material, a polymer, a foodstuff, a paint, a primer, and a coating.

123. The composition of claim 121, wherein the composition comprises not more than 70% of the mineralized ash filler.

124. A method of increasing the tensile modulus of a plastic, the method comprising incorporating up to about 60% by weight of a mineralized ash filler into the plastic.

125. A method of increasing the stiffness of a plastic, the method comprising incorporating up to about 60% by weight of a mineralized ash filler into the plastic.

126. A method of increasing the surface hardness of a plastic, the method comprising incorporating up to about 60% by weight of a mineralized ash filler into the plastic.

127. A method of increasing the elongation at break of a plastic, the method comprising incorporating up to about 45% by weight of a mineralized ash filler into the plastic.

128. A method of increasing the impact resistance of a plastic, the method comprising incorporating up to about 45% by weight of a mineralized ash filler into the plastic.

129. A method of decreasing the viscosity of a molten thermoplastic, the method comprising incorporating up to about 25% by weight of a mineralized ash filler into the plastic.

130. A method of enhancing the processibility of a molten thermoplastic, the method comprising incorporating up to about 25% by weight of a mineralized ash filler into the plastic.